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Publicized Report of Patent

Detailed Report

(Name of the invention)
MOLD FOR DISC SUBSTRATE

Outline
(Object)
This invention controls sink and swell generated in the peripheral part of a molded disk substrate.

(Solution)
This invention is a mold for molding a disk substrate which consists of a fixed mold body 3 and a movable mold body 4 which have cavities 3A, 4A which are filled with resin, stampers 5A, 5B which are used to transcribe a pattern on the disk substrates which are molded in the cavities 3A, 4A. In the fixed mold body 3 and movable mold body 4, the periphery of the cavities 3A, 4A is tapered parts 13, 14 to reduce the thickness of the disk substrate gradually from the inside toward the outside.

Sphere of request of the patent

(claim 1)
Claim 1 is regarding a mold for a disk substrate which has the following characteristics. It consists of a fixed mold body and movable mold body having cavities for molding a disk substrate by injecting resin material, stampers which are formed by transcribing a pattern on a disk substrate which is molded on the cavity parts. In at least one of these mold bodies, the periphery of the cavities is tapered so that the thickness of the disk substrate is gradually reduced from the inside toward the outside.

(claim 2)
Claim 2 is regarding the mold for a disk substrate in claim 1 which has the following characteristics. It consists of a pair of mold bodies which have cavities that form the front and back sides of a disk substrate, annular parts that form the outer periphery of the disk substrate combined with the periphery of the cavities in the mold bodies. Also, the outer periphery of the stamper is supported by the annular part.

Detailed explanation of the invention
[0001]
(Field of industrial use)
This invention is regarding a mold for a disk substrate which is used to form a pattern on a disk substrate that constitutes a disc shaped memory medium such as an optical or magnetic disk.

(Prior art)

Former disc shaped memory media such as magnetic disks or optical magnetic disks have a servo pattern or track pattern inside the signal memory area in order retrieve data signals from memory

[0003] For example, a disk shaped substrate for a memory medium such as a magnetic disk is formed by injection molding. The mold consists of a fixed mold body and movable mold body that move toward or away from each other. A stamper is placed inside the mold bodies. The stamper has a pattern such as a servo pattern or track pattern that is transferred to the surface of the disk substrate.

[0004] Resin is injected into a cavity formed by the fixed mold body and movable mold body. The part of the fixed mold body and movable mold body where the stamper is attached has a flat, smooth, highly accurate surface due to a mirror finishing process.

[0005] The stamper is set up in each cavity of fixed mold body and movable mold body. The stamper is used to transcribe pattern in the data signal region of the front and back of the molded disk substrate.

[0006] In the molding process, first the movable mold body is closed against the fixed mold body with relatively low force. After the clamp pressure is increased, the nozzle of the injection equipment is connected. Molten resin is injected into the cavity at high pressure. After this, the resin is cooled and solidified in the mold to form a disc substrate.

[0007]

(Problems that this invention tries to solve)

Meanwhile, as shown in figure 4, the disk substrate 50 formed by using this mold shrinks as the resin cools and solidifies. There have been problems with approximately 10 μm sink 51 or approximately 20 μ swell 52 caused by pressure are generated on the front and back sides of the outer periphery of the disc substrate.

[0008] When the disk substrate 50 is used, for example, as a magnetic disc, the sink 51 or swell 52 at the outer periphery sometimes causes head damage.

[0009] When the disk substrate 50 is used as an optical disk such as an optical magnetic disk, the distance between the magnetic head for recording data signals and the signal recording face must be increased in order to avoid the sink 51 or swell 52. This causes problems with signal erasing efficiency or dropouts.

[0010] Accordingly, in order to remove the sink 51 or swell 52 at the outer periphery, it is necessary to trim the disk substrate 50 to remove the outer periphery. Because of this, the manufacturing process for the disk substrate 50 has lower yield and more process steps. This causes the manufacturing cost of the disk substrate 50 to be high.

[0011] Therefore, the object of this invention is to offer a mold for a disk substrate that can control generation of sink or swell at the outer periphery of the disk substrate.

[0012]

(Steps for solution)

In order to attain the above object, this invention consists of a mold for a disk substrate which consists of a fixed mold body and a movable mold body which have cavities which are filled with resin and stampers which are used to transcribe a pattern on the disk substrates which are molded in the cavities. In the fixed mold body and movable

mold body, the periphery of the cavities is tapered to reduce the thickness of the disk substrate gradually from the inside toward the outside.

[0013] The mold for a disk substrate above has a tapered part at the periphery which causes a gradual reduction in thickness of the disk substrate from the inside toward the outside.

[0014] The stamper is made to conform to the shape of the cavity by pressure when the resin is injected into the cavity. The molded disk substrate will contain a negative image of the pattern set up on the stamper.

[0015]

(Examples of practice of this invention)

In the following, concrete examples of practice of this invention which use this mold for molding magnetic disk substrates will be explained using figures. This magnetic disk is used in a hard disk drive for a computer.

[0016] As shown in figure 1, the mold 1 in this example of practice has a fixed mold body 3 and movable mold body 4 which have cavities 3A, 3B for molding the front and back sides of the disk, stampers 5A, 5B which transcribe a pattern like a servo pattern on the molded disk substrate, an annular part that forms outer periphery of the disk substrate when combined with the fixed mold body 3 and movable mold body 4, and cooling equipment 7A, 7B, and 7C which cool the fixed mold body 3, movable mold body 4, and annular mold body 6.

[0017] This mold 1 has a sprue bushing 9 which has a sprue 9A that introduces resin to the cavity 3A, 3B when combined with the fixed mold body 3, ejector pins 10 which discharge the molded disk substrate from the movable mold body 4, a punch 11 which cuts the center hole in the disk substrate, and a pin 12 which discharges the center which has been cut from the disk substrate.

[0018] In the fixed mold body 3 and movable mold body 4, a cavities 3A, 4B corresponding to the size and shape of the disk substrate to be molded are formed. These cavities 3A, 4A are mirror finished inside. Resin is injected into these cavities 3A, 4A.

[0019] As shown in figure 2, the part of the fixed mold body 3 and movable mold body 4 over the peripheral parts of the cavities 3A, 4A is tapered 13, 14 which reduces the thickness of the disk substrate gradually from the inside toward the outside.

[0020] These tapered parts 13, 14 are inclined at approximately 15/1000 toward the outer periphery starting 1 to 2 mm in from the edge of the disk substrate. In other words, these tapered parts 13,14 correspond to a 15 to 30 μm reduction in thickness of the disk substrate. The tapered parts 13, 14 may correspond to a 5 to 200 μm reduction in thickness of the disk substrate depending on the application.

[0021] In this example, the tapers 13, 14 are set up in both the fixed mold body 3 and movable mold body 4. However, when a disk substrate which has data on only one side is molded, it is acceptable to make the taper on only the data side of the cavity.

[0022] The cavities 3A, 4A are not limited to a construction which uses a linear taper. As long as it has a shape where the thickness of the disk substrate is gradually reduced from the inside toward the outside, other shapes such as an arc can be used.

[0023] The fixed mold body 3 and movable mold body 4, as shown in figure 1, cooling circuits 3B, 4B which circulate a cooling solution such as water or oil. The cooling circuits 3B, 4B are each connected to a cooling device 7A, 7B.

[0024] Stampers 5A, 5B are disks which are slightly bigger than the diameter of the disk substrate to be molded, and they are approximately 0.3 mm thick. These stampers 5A, 5B have a predetermined pattern such as a servo pattern or track pattern for tracking control on the surface which contacts the resin. The stampers form pit shapes in the molded disc substrate. Since the back of the stampers are polished, a smooth, flat, highly accurate surface is formed.

[0025] The outer periphery of the stampers 5A, 5B is supported by the fixed mold body 3 and movable mold body 4 through an annular body 6. The annular body 6 is fixed by a screw 16 so that it supports the outer periphery of the stampers 5A, 5B in a predetermined position.

[0026] Stampers 5A, 5B will not move in the radial direction so the pattern can be transcribed and formed on the disk substrate with high accuracy.

[0027] In addition, the cooling circuit 6A which contains a cooling solution such as water or oil is formed in the annular body 6 as shown in figure 1. This cooling circuit 6A is connected to a cooling device 7C.

[0028] Cooling devices 7A, 7B, and 7C are each furnished with temperature controls (not shown in the figure) which are used to adjusts the temperature of the cooling solution. The temperature of each cooling circuit in the fixed mold body 3, movable mold body 4, and annular mold body 6 can be controlled independently. In other words, the temperature of each mold body 3, 4, 6 is controlled by cooling devices 7A, 7B, and 7C respectively.

[0029] For the mold 1 with the construction above, the injection molding process which fills cavities 3A, 4A is going to be explained using figure 3. First, the mold 1 is closed by moving the movable mold body 4 to the fixed mold body 3and clamped. Molten resin is introduced through the sprue 9A and sprue bushing 9 by an injection device (not shown in the figure). The cavities 3A, 4A in the mold 1 are filled with resin at a predetermined pressure.

[0030] Stampers 5A, 5B inside the cavities 3A, 4A are made to conform to the shape of inside of the cavities 3A, 4A by pressure when the resin materials are injected into the cavities 3A, 4A.

[0031] The thickness of the disk substrate molded by the cavities 3A, 4A will be gradually reduced from the inside toward the outside near the periphery in accordance with the tapered parts 13,14. Because of this, this disk substrate will not sink or swell near the periphery.

[0032] This disk substrate will have the pattern formed on each stamper 5A, 5B transcribed on both front and back. The mold 1 will be opened after the disk substrate is cooled and solidified. The disk substrate is peeled off the stamper 5A, 5B and ejected from the mold. The molded disk substrate is made into a magnetic disk by applying a magnetic coating and a protective coating on the surface.

[0033] When the mold 1 has a taper of approximately 15/1000 starting at about 1 mm inside the outer periphery of the disk substrate, both sink and swell produced at the outer periphery of the molded disk substrate will be less than 1 μm.

[0034] When the mold 1 has a taper of approximately 15/1000 starting about 2 mm inside the outer periphery of the disk substrate, both sink and swell produced at outer periphery of the molded disk substrate will be less than 0.2 μm.

[0035] As state above, since the mold in this example of practice has tapered parts 13, 14 in the cavities 3A, 4A of the fixed mold body 3 and movable mold body 4, the thickness of the disk substrate is gradually reduced from the inside toward the outside. Therefore, it is possible to control generation of sink or swell at the outer periphery of the disk substrate to be molded effectively.
[0036] Since this mold 1 makes it possible to control of sink or swell at the outer periphery of the disk substrate effectively, trimming the molded disc is unnecessary, so manufacturing costs can be reduced, and it is possible to offer an inexpensive disk substrate.
[0037] Furthermore, although the mold 1 in this example of practice has been adopted for molding a substrate for a magnetic disk, this invention is not limited to only magnetic disks. For example, it can be adopted for forming substrates such as optical disks, optical magnetic disks, or other disc shaped memory medium.

[0038]
(Effects of this invention)
As stated above, since the mold for a disk substrate in this invention forms a disc substrate where the thickness is gradually reduced from the inside toward the outside over the outer edges of the cavity, it is possible to control sink or swell at the outer edges of the disk substrate effectively.
[0039] Since a trimming process is not required for the disc substrate made with the mold in this invention, it becomes possible to reduce manufacturing costs. As a result, a disk substrate can be offered at low price.

(Simple explanation of figures)
figure 1: model used to explain the construction of the mold in one example of practice of this invention.
Figure 2: vertical section which shows the main parts of the above mold.
Figure 3: vertical section which shows the main parts of the above mold.
Figure 4: vertical section which shows the main part of a disk substrate molded using a former mold.

(Explanation of numbers in figures)
1: mold
3: fixed mold body
4: movable mold body
3A, 4A: cavity
5A, 5B: stamper
6: annular mold body
13, 14: tapered parts